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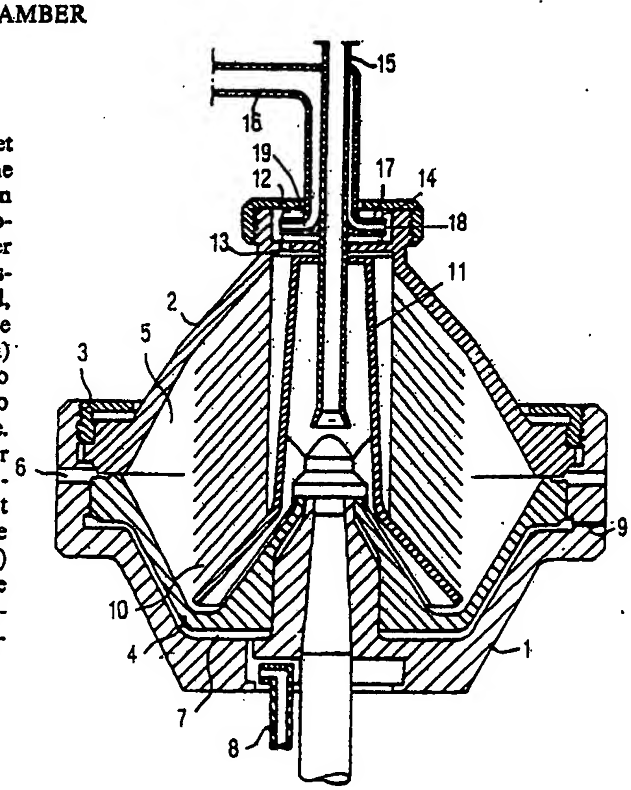
(54) Title: DISCHARGE DEVICE WITH A VORTEX CHAMBER

(57) Abstract

Centrifugal separator in which a rotor forms an inlet for a liquid mixture, a separation chamber connected to the inlet and a discharge chamber connected to the separation chamber. During operation of the rotor a separated component forms a rotating liquid body in the discharge chamber with a radially inwards directed free liquid surface. In the discharge chamber a stationary discharge device (17a) is located, which during operation of the rotor extends radially outside said free liquid surface with a part, in which two inlets (18a) are arranged. These inlets (18a) are separately connected to an outlet (16) connected to the discharge device (17a) via two separate outlet passages (23a) formed in the discharge device. In order to increase the rotor dynamical stability of the rotor and to decrease the risk for air mixture in the separated component discharged through the discharge device (17) at least one vortex chamber (20a) is formed in the discharge device (17) and is so connected with at least one of said inlets (18a) that a component flowing through the inlets (18a) during the operation of the rotor gets a rotational movement in the vortex chamber which acts stabilizing on the flow through the inlet (18a).



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Discharge device with a vortex chamber.

The present invention concerns a centrifugal separator having a rotor, which forms an inlet for a liquid mixture, a separation chamber, connected to the inlet, for separation of components of the liquid mixture and a discharge chamber, connected to the separation chamber, for discharge of a separated component. The discharge chamber is so designed that a separated component present therein upon operation of the rotor forms a rotating liquid body having a radially inwards directed free liquid surface. The centrifugal separator also comprises a stationary discharge device, which is located in the discharge chamber and during operation of the rotor extends radially outside the free liquid surface of said liquid body with a part, in which at least two inlets are arranged. These inlets are separately connected to an outlet connected to the discharge device via at least two separate flow passages, which are formed in the discharge device.

An advantage with a centrifugal separator of this kind is that the kinetic energy of the liquid body rotating in the discharge chamber can be transformed to pressure energy in the stationary discharge device and then be used for further transportation of the discharged separated component. Hereby an extra pump in the outlet conduit often can be avoided. However, it is difficult to get the rotor in such a centrifugal separator to rotate in a rotor-dynamically stable manner.

The oscillating movements of a centrifuge rotor may have many different causes. They can be caused by internal forces acting on the different rotor parts, such as unbalance forces, and they can be caused by external forces acting on the rotor and deriving from stationary elements in the vicinity of the rotor. The above mentioned stationary discharge device constitutes one such element, which can give rise to oscillating movements of the rotor.

The influence of the discharge device on the oscillating movements of the rotor can depend on minor production related defects of the discharge device and/or on eccentricity between the centre of the latter and the rotational axis of the rotor. During operation of the rotor this can give rise to varying liquid flows through the different inlets of the discharge device and also in the discharge chamber surrounding the discharge device. Such varying flows can in turn lead to oscillating movements of the rotor. It has proved to be very difficult to avoid fluctuations in the flow through the inlets of the discharge device. The liquid flows through the different inlets sometimes even change direction. The varying flows also can cause the rotational centre of the rotating liquid body to take a varying position radially relative to the rotational axis of the rotor and the stationary discharge device.

Radial movements of the free liquid surface in the discharge chamber also means a risk that air or some other gas present radially inside the liquid surface may be entrained by and be mixed into the liquid flowing through the inlets. One way to decrease the risk for such an air mixing is to increase the counter pressure in the outlet from the discharge device, whereby the free liquid surface can be moved radially further inwards, so that it will be at a greater distance from the inlets. In the Danish patent specification 56 589 there is shown a stationary discharge device, in which the inlets are provided with mechanical tongues, which close the inlet openings when this distance is smaller than a certain value. By means of such an arrangement liquid can be prevented from flowing radially outwards out from the discharge device. However, the problem with a fluctuating flow through the separate inlets remains.

The object of the present invention is to provide a centrifugal separator of the kind initially described, in which the kinetic energy of the liquid in the discharge chamber can be transformed

to pressure energy by means of the stationary discharge device in such a way that fluctuations in the liquid flow within and around the discharge device are counteracted to an essential degree.

According to the invention this can be accomplished by having at least one vortex chamber formed in the discharge device and so connected with at least one of said inlets that a component flowing into the vortex chamber during operation gets a rotational movement therein, intended for stabilization of the flow through the inlet, one of the flow passages in the discharge device, including said vortex chamber, being separate from the other flow passage in the discharge device.

By this invention oscillating movements of the rotor deriving from a somewhat incorrect form or location of the stationary discharge device can be substantially avoided. Further, there is reason to presume that a discharge device formed according to the invention also can have a damping effect on oscillations of the rotor, being caused by other reasons.

In a preferred embodiment of the invention there is formed at least two vortex chambers in the discharge device. These can advantageously be connected each with one separate inlet. One or more vortex chambers can also communicate with two or more inlets.

Preferably there is a hole arranged in the discharge device at the centre of each vortex chamber, through which the vortex chamber communicates with the surroundings of the discharge device. Hereby the air or gas present radially inside the rotating component in the chamber can be evacuated.

In the following the invention will be described in more detail with reference to the accompanying drawings, in which

Fig 1 shows schematically an axial section through a part of a centrifugal separator according to the invention,

Fig 2 shows a three dimensional view of a part of a centrifugal separator according to one embodiment of the invention,

Fig 3 shows the part shown in fig 2 seen in axial direction,

Fig 4 shows a three dimensional view of an alternative embodiment of the detail shown in figures 2 and 3,

Fig 5 shows the detail shown in fig 4 seen in axial direction,

Fig 6 shows schematically a radial cross-section through another alternative embodiment of the detail shown in fig 2 and 3 in a centrifugal separator according to the invention and

Fig 7 shows schematically a radial cross-section through still another alternative embodiment of the detail shown in figs 2 and 3.

Details which correspond to each other in the different figures have been allotted the same reference numbers, whereas different embodiments of a detail have been distinguished in the figures by addition of a letter to the reference number of each embodiment.

The centrifugal separator shown in figure 1 comprises a rotor, which has a lower part 1 and an upper part 2, which are kept together axially by means of a locking ring 3. Inside of the shown example there is arranged an axially movable valve slide 4. This valve slide 4 delimits together with the upper part 2 a separation chamber 5 and is arranged to open and to close an annular gap towards outlet openings 6 for a component, which has been separated out of a mixture supplied to the rotor, and

collected at the periphery of the separation chamber 5. The valve slide 4 delimits together with said lower part 1 a closing chamber 7, which is provided with an inlet 8 and a throttled outlet 9 for a so called closing liquid.

Within the separation chamber 5 a disc stack 10 consisting of a number of conical separation discs is arranged between a distributor 11 and the upper part 2. The upper part 2 forms at its upper end shown in the figure a discharge chamber 12, to which a specifically lighter liquid component of the mixture can flow from the separation chamber 5 via a passage 13.

The component present in the discharge chamber 12 during operation of the rotor forms a rotating liquid body having a radially inwards directed free liquid surface 14.

Centrally through the discharge chamber 12 there is arranged a stationary inlet tube 15, which opens into the interior of the distributor 11. Around this inlet tube 15 a stationary outlet tube 16 for the specifically lighter component extends into the discharge chamber 12. Within the discharge chamber 12 a stationary discharge device 17 is arranged around the inlet tube 15 and connected to the outlet tube 16.

The discharge device 17, the interior of which thus is connected to the interior of the outlet tube 16, extends radially outside the radial level of the free liquid surface 14 of the rotating liquid body with a part, in which at least two inlets 18 are formed. These inlets 18 are separately connected to the interior of the outlet tube 16 via at least two separate flow passages 19 formed in the discharge device 17. One embodiment of a discharge device 17a in a centrifugal separator according to the invention is shown more in detail in figures 2 and 3. In these figures only one of the two above mentioned flow passages has been drawn in the discharge device 17a.

In the discharge device 17a there is formed a vortex chamber 20a is formed consisting of two circular cylindrical departments, one department 21a being formed with a larger radius than the other department 22a and the axes of both of the departments being coaxial and parallel to the rotational axis of the rotor. The two departments are located axially close to each other and communicate with each other at a common cross-section. The radius of said one department 21a is larger than the distance between the circumferential surface of the discharge device 17a and the centre of the department 21a, whereby an inlet 18a is formed in the circumferential surface of the discharge device 17a.

The second department 22a is connected to the interior of the outlet tube 16 via an outlet passage 23a. The outlet passage 23a is connected tangentially to said second department 22a, whereas it is connected radially to the outlet tube 16. At the centre of the vortex chamber 20a there is arranged a deaeration hole 24a axially through the wall of the discharge device 17a for communication between the central parts of the vortex chamber 20a and the surroundings of the discharge device 17a.

Figures 4 and 5 show an alternative embodiment of a discharge device 17b in a centrifugal separator according to the invention. This embodiment differs from the embodiment shown in figures 2 and 3 in that the vortex chamber 20b of the same is not divided into two departments but consists of only one circular cylindrical part, which is provided with an inlet 18b and is connected to the interior of the outlet tube 16 via an outlet passage 23b. The outlet passage 23b is connected to an axial end surface of the vortex chamber 20b and is tangentially directed relative to the latter at the point of connection. The outlet passage 23b is radially directed relative to the rotational axis of the rotor at the connection to the interior of the outlet tube 16.

In figure 6 there is shown very schematically a radial cross-section through a discharge device 17c, which differs from the discharge device 17b shown in figures 4 and 5 in that the outlet passage 23c in the same is connected tangentially to the circumferential surface of the vortex chamber 20c.

In figure 7 there is shown very schematically a radial cross-section through another embodiment of a discharge device 17d. In this discharge device 17d the vortex chamber 20d is connected with two inlets comprising one inlet passage 25d each. These inlet passages 25d connect tangentially to the adherent inlet opening 26d and to the circumferential surface of the vortex chamber 20d.

Of course, more than two inlet openings 26d can be connected to one and the same vortex chamber 20d in this manner. Alternatively, a vortex chamber 20d can be connected to only one inlet via one inlet passage 25d.

A centrifugal separator designed according to the invention functions in the following manner:

Upon start of a centrifugal separator of this kind the rotor is brought into rotation and the separation chamber 5 is closed by the supply of a closing liquid to the closing chamber 7 through the inlet 8. When the separation chamber 5 is closed the liquid mixture that is to be centrifugally treated is supplied to the separation chamber 5 through the inlet tube 15 and the distributor 11. Gradually the separation chamber 5 is filled up, the rotor reaches operational number of revolutions and the conditions inside the separation chamber 5 is stabilized, whereupon the components in the liquid mixture are separated by the influence of centrifugal forces acting on the same. The separation mainly takes place in the space between the conical discs in the disc stack 11. During separation a specifically heavier

liquid component is thrown radially outwards and is collected in the radially outer part of the separation chamber, whereas a specifically lighter liquid component flows radially inwards in these spaces.

In the example shown in figure 1 the supply of closing liquid to the closing chamber 7 is interrupted when needed or at equal time intervals. The closing liquid present in the closing chamber 7 is drained off continuously through the throttled outlet 9. The closing force from the closing liquid, which acts on the valve slide 4, is thereby decreasing and finally is not capable to keep the annular gap between the separation chamber 5 and the outlet openings 6 closed against the force from the liquid mixture present in the separation chamber and the specifically heavier liquid component flows out through the outlet openings 6. The supply of closing liquid is kept interrupted during a predetermined time, whereupon the closing liquid is supplied again to the closing chamber 7. The annular gap is then closed again.

The specifically lighter liquid component flows out of the separation chamber 5 through the passage 13 to the discharge chamber 12, in which it forms a rotating cylindrical liquid body having a radially inwards directed free liquid surface 14. The liquid component present in the discharge chamber 12 flows in through an inlet 18 in the discharge device 17 to a vortex chamber either directly (Fig 2-6) or via an inlet passage (Fig 7). The discharge device is so designed that the component flows essentially tangentially into the vortex chamber so that it keeps a rotational movement therein. The air, which for instance upon start is located in the vortex chamber is evacuated completely or partly through the deaeration hole 24a. The component flows further out of the vortex chamber through the outlet passage 23a-d, which is connected to the vortex chamber essentially tangentially relative to this. The rotational

movement of the component present in the vortex chamber means, due to the inertia of the rotating mass, that the flow through different flow passages in the discharge device is stabilized. This means in turn that the oscillating movements of the rotor decrease and that the free liquid surface 14 of the rotating liquid body in the discharge chamber 12 is stabilized. The decreasing radial movements of the free liquid surface 14 also mean that the risk for air mixture into the discharged component through the discharge device decreases.

In the shown embodiments the outlet passage 23a-d is connected radially relative to the rotational axis to the interior of the outlet tube 16. It can also with advantage be connected axially to the interior of the outlet tube 16.

Claims

1. Centrifugal separator comprising a rotor, which forms an inlet for a liquid mixture, a separation chamber (5), connected to the inlet, for separation of components of the liquid mixture and a discharge chamber (12), connected to the separation chamber (5), for discharge of a separated component, the discharge chamber (12) being so formed that a separated component present therein during operation forms a rotating liquid body having a radially inwards directed free liquid surface (14), the centrifugal separator further comprising a stationary discharge device (17), which is located in the discharge chamber (12) and during operation of the rotor extends radially outside said free liquid surface (14) of the liquid body with a part, in which there are arranged at least two inlets (18) separately connected to an outlet (16) that is connected to the discharge device (17) via at least two separate flow passages (19) formed in the discharge device, c h a r a c t e r i z e d i n that at least one vortex chamber (20a-d) is formed in the discharge device (17) and is so connected with one of said inlets (18) that a component flowing into the vortex chamber (20a-d) during operation gets a rotational movement therein, intended for stabilization of the flow through the inlet (18), one flow passage (19) in the discharge device (17), including said vortex chamber (20a-d), being separate from the other flow passage in the discharge device (17).

2. Centrifugal separator according to claim 1, c h a r a c t e r i z e d i n that at least two vortex chambers are arranged in the discharge device (17).

3. Centrifugal separator according to claim 2, c h a r a c t e r i z e d i n that each vortex chamber is connected to its own inlet (18).

4. Centrifugal separator according to claim 2, c h a r a c - t e r i z e d i n that at least one of the vortex chambers (20d) is connected to at least two inlets (26d).

5. Centrifugal separator according to any of the claims 2-4, c h a r a c t e r i z e d i n that the vortex chambers are located with their central axes parallel to the rotational axis of the rotor on a circle concentrical therewith, preferably evenly distributed around the rotational axis.

6. Centrifugal separator according to any of the preceding claims, c h a r a c t e r i z e d i n that a deaeration hole (24) is arranged in the discharge device (17) at the centre of each vortex chamber for communication between the vortex chamber and the surrounding of the discharge device (17).

7. Centrifugal separator according to claim 1 or 2, c h a - r a c t e r i z e d i n that said one flow passage (19) also comprises an inlet passage (25d) formed in the discharge device and connected to the inlet opening (26d) at its one end and to the vortex chamber (20d) at its opposite end.

8. Centrifugal separator according to any of the preceding claims, c h a r a c t e r i z e d i n that said one flow passage (19) also comprises an outlet passage (23a-d), that is formed in the discharge device (17), and at its one end is connected to the vortex chamber (20a-d) tangentially relative thereto and at its opposite end is connected to the outlet (16).

9. Centrifugal separator according to claim 8, c h a r a c - t e r i z e d i n that the outlet passage (23c, 23d) is connected to the vortex chamber (20c, 20d) at its circumferential wall.

10. Centrifugal separator according to claim 8, characterized in that the outlet passage (23a, 23b) is connected to the vortex chamber (20a, 20b) radially inside the circumferential wall of the same.

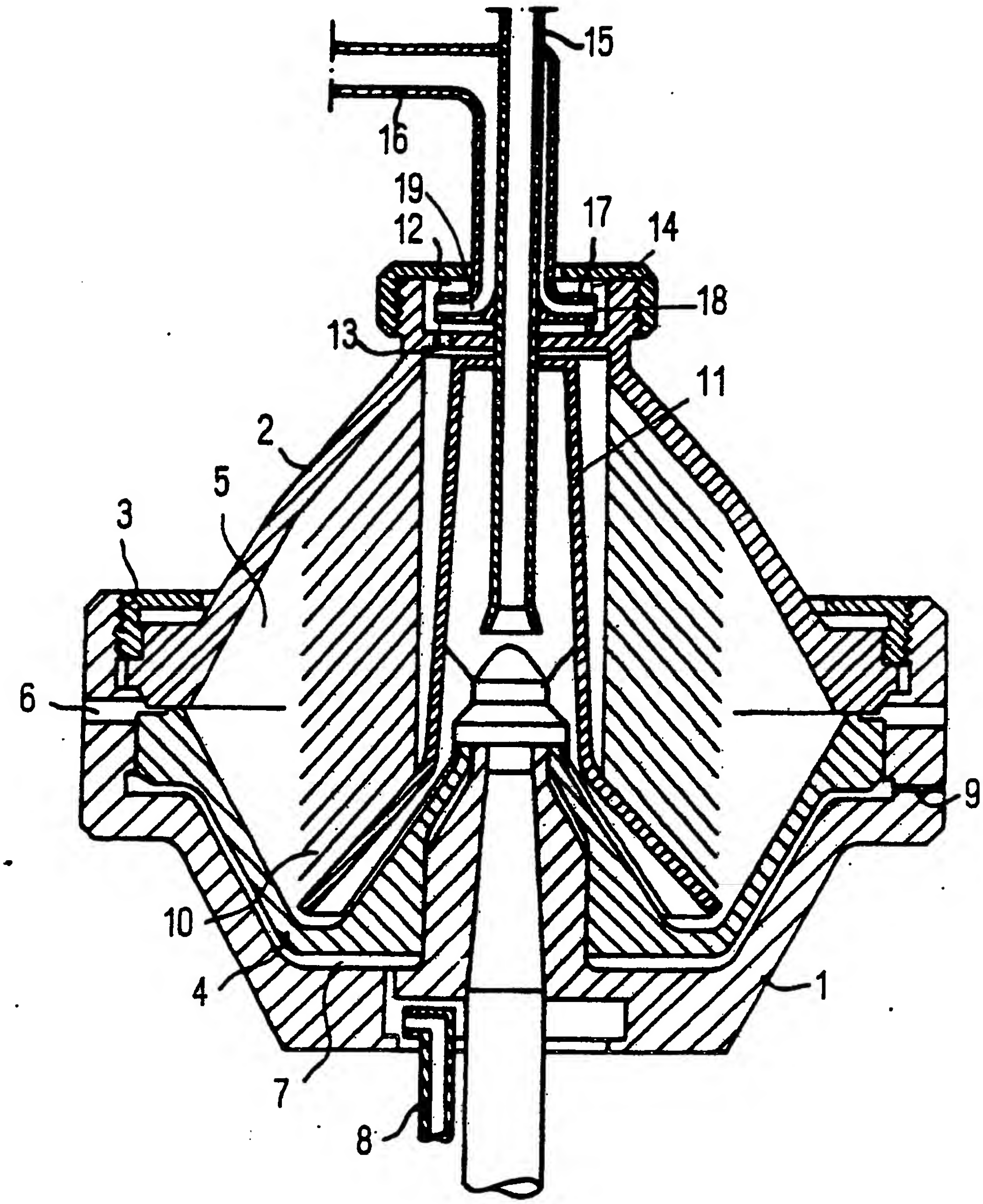


Fig. 1

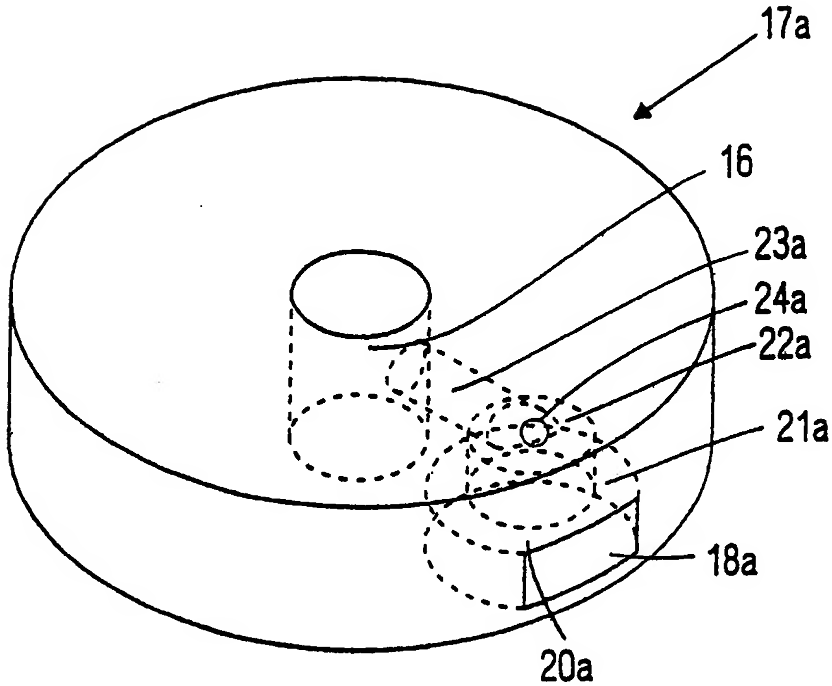


Fig. 2

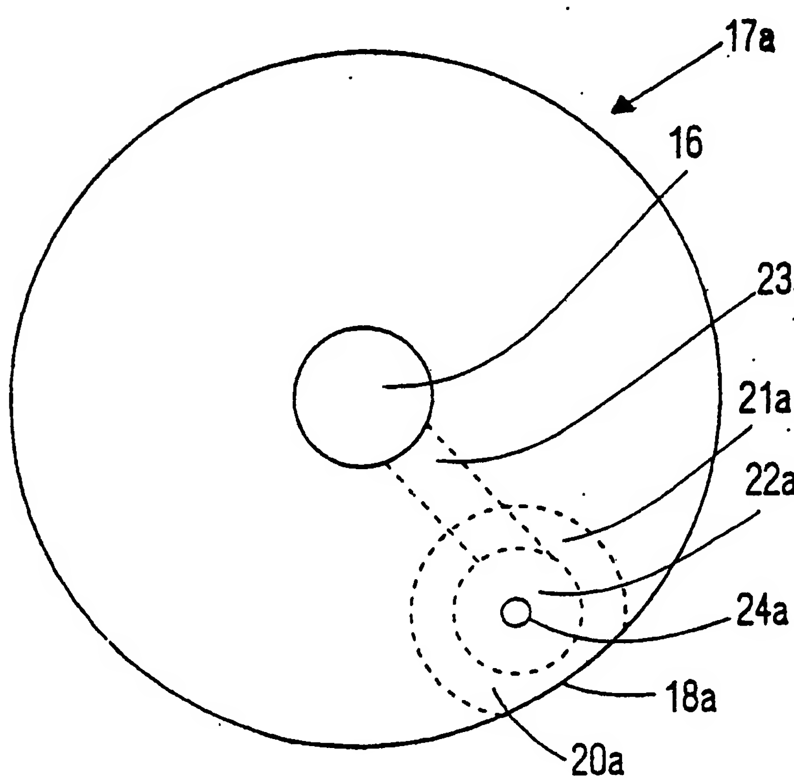


Fig. 3

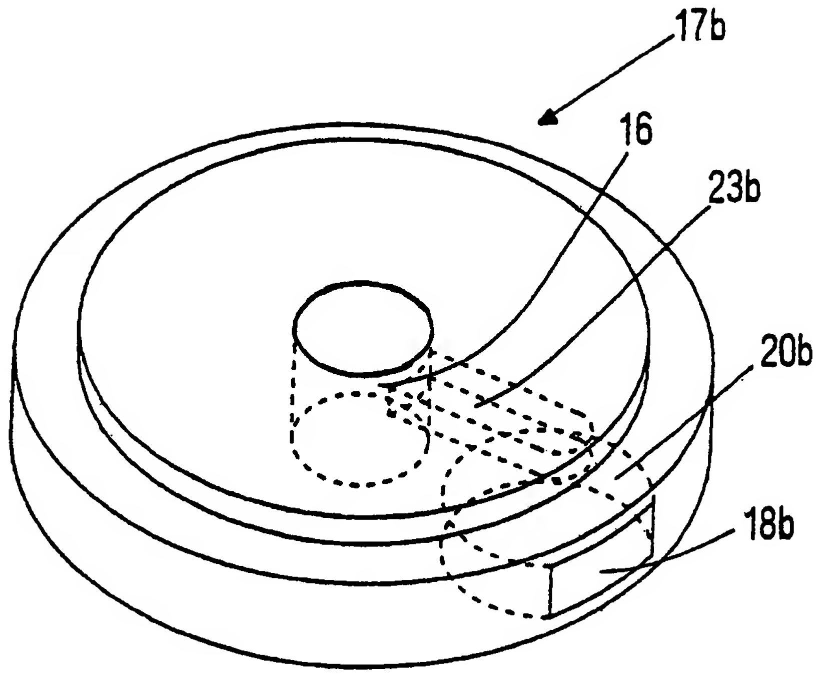


Fig. 4

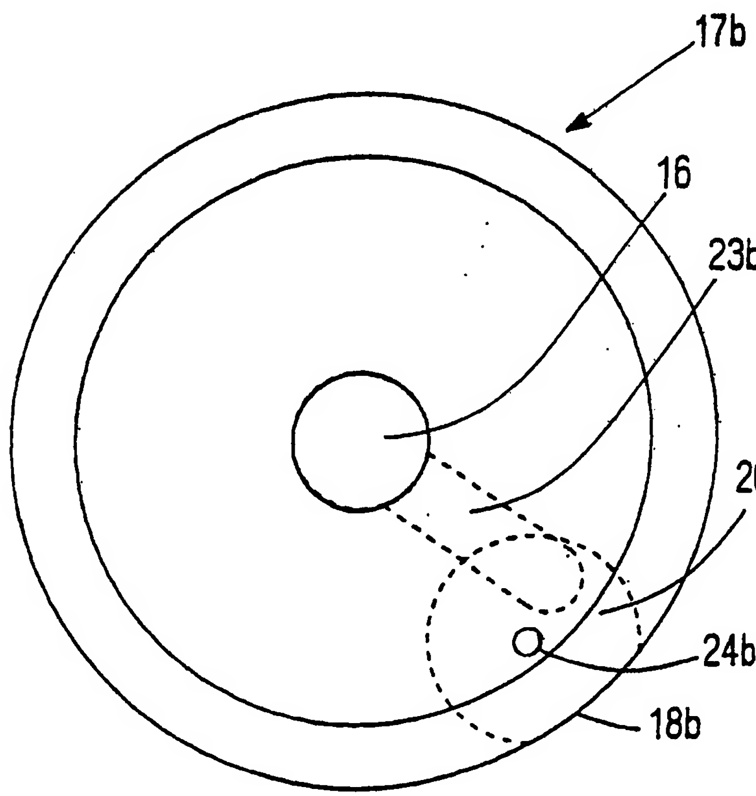
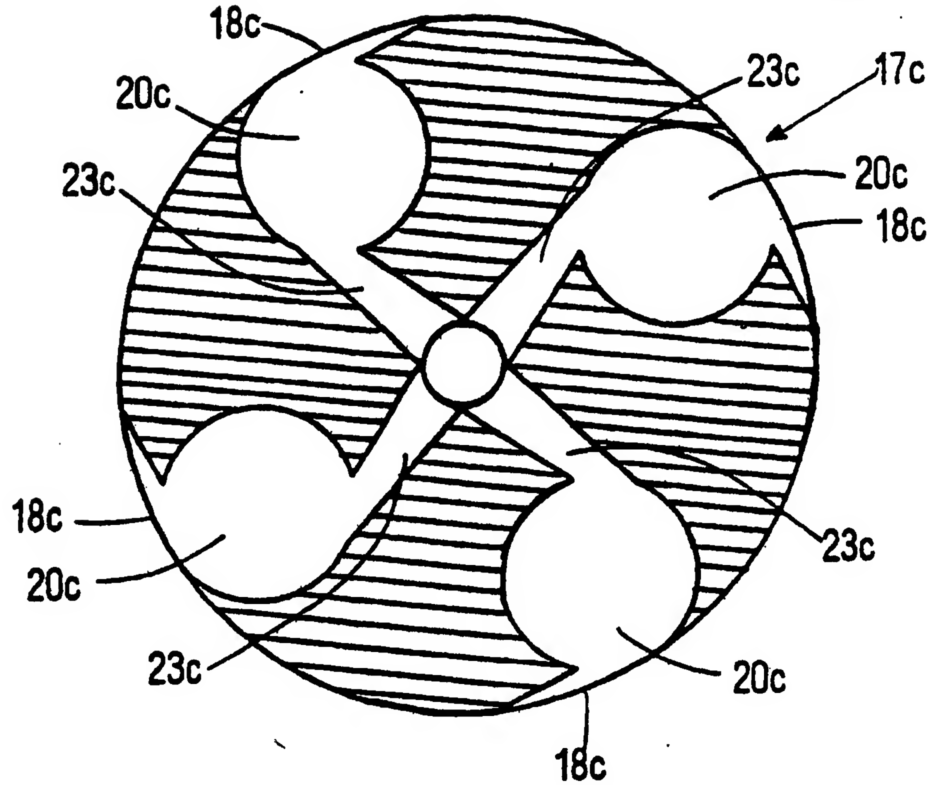


Fig. 5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18c

Fig. 6

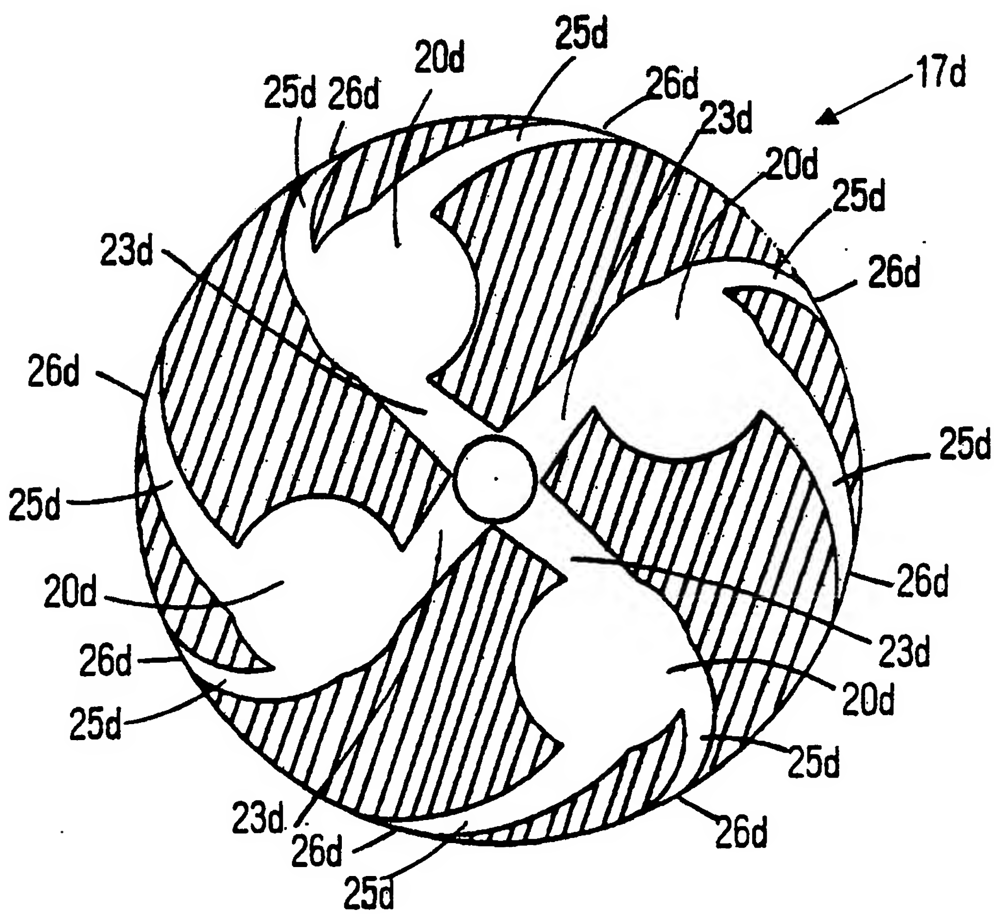
25d
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Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE88/00181

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [8]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

B 04 B 11/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	B 04 B 11/00-/04, /06, 1/00-/10
Nat Cl	82b:V, 6/03, 15
US Cl	233:16,19-21, 27-47; 494:1-4, 43-85

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	SE, B, 427 248 (ALFA-LAVAL AB) 21 March 1983	
A	DE, A, 1 130 371 (KRAUSS-MAFFEI AKTIENGESELLSCHAFT) 24 May 1962	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
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